

INTRODUCTION

As documented in the Purpose and Need Statement, there are many needs in Southwest Indiana which the I-69 project could address. There are several dozen performance measures associated with these needs. The cost of each alternative (both capital and ongoing operating and maintenance (O&M)) also are major factors in the comparison of alternatives. In addition, geographic diversity is a criteria in alternative screening.

This gives rise to several related questions. These include:

- How sensitive is this analysis to the relative importance (weight) assigned to different decision criteria? Are the results fairly consistent if a wide variety of weights are assigned to the different decision criteria? Or, do the results of the analysis vary, depending upon the relative weight given to various criteria?
- How sensitive are the results to geographic grouping? There are different ways in which routes can be grouped geographically. Can the results be significantly affected by how routes are grouped geographically?

In order to answer these questions, a ***sensitivity analysis*** was performed as part of the analysis leading up to the Screening of Alternatives. As described below, the analysis showed that there was a great degree of consistency in rankings of routes under a wide variety of assumptions.

DEFINITIONS

In order to understand the sensitivity analysis, a few key definitions are in order:

Sensitivity Analysis - a comparison of results obtained in an analysis under a variety of assumptions. An analysis scheme is said to be *robust* if it produces similar results given a wide variety of assumptions.

Route Score – an aggregate or weighted average score between 0 and 100 that summarizes the performance of an alternative. The score considers all the performance families *and cost factors* (i.e., capital and O&M) discussed in the main text of this screening report.

Weighting – the process of multiplying the composite score associated with a performance family with a value indicative of the relative importance of the performance family or cost. In addition to the application of weights to performance families, weights may be applied to the three overarching goals of I-69: transportation, economic development, and national I-69 objectives.

Scenario – A set of assumed weights and the route scores and rankings associated with those weights.

Geographic Grouping – A grouping of the 19 routes (i.e., 14 plus options) into “core groups” based on some common element of the routes’ geography. It is possible to conceive of several different geographic groupings; for example, routes grouped by the highway corridors used to approach Evansville, or routes organized by broad geographic region.

Core Group – Two or more routes with a common element based on the geographic grouping’s organizing principle (e.g., routes that approach Evansville using US 41).

Sensitivity Analysis

The sensitivity analysis sought to determine whether routes consistently have high route scores, regardless of scenario and geographic grouping. When they do, the analysis can be described as robust. If the overall ranking of routes varies significantly, depending upon the scenario, then very careful judgments must be made regarding the importance of different criteria.

The geographic groupings are significant given INDOT’s policy directive to carry forward a geographically diverse set of alternatives for Level-3 analysis. This policy of geographic diversity should ensure the selection of a set of route concepts that respects the wide diversity of both public input and natural resources that exist in southwestern Indiana.

The significance of considering alternative scenarios is designed to ensure that the routes carried forward for detailed study are not dependent on a single set of values with respect to the performance families and cost factors described earlier.

The methodology uses the following iterative, five-step process.

- Categorize each route concept into core groups based on a logical geographic grouping.
- Compute route scores based on a reasonable weighting scenario and rank the routes based on their respective route scores.
- Note the route within *each core group/geographic grouping* with the best (lowest) rank.
- Repeat steps (1) through (3) for a reasonable range of scenarios and geographic groupings.
- Identify the top-performing route concepts that most frequently achieve the lowest ranking across several scenarios and geographic groupings.

Geographic Groupings

There are several ways that the route concepts could be grouped. A total of five such groupings were developed that provide a wide spectrum of approaches to the grouping question. These groupings are listed below. The list includes a brief description of the organizing principle around which the groupings were developed. It also identifies the core groups that comprise each geographic grouping. The list is color-coded to assist the reader in picking out the high-scoring routes in each grouping.

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Geographic Grouping A: Organized by highway corridor utilized

Core Group 1: Mostly direct routes between Indianapolis and Evansville – B1, B2, F1, F2, G, H1, H2, K

Core Group 2: Routes utilizing a significant amount of US 41 – A, C1, C2, D, E

Core Group 3: Route utilizing a significant amount of I-70 – I, J

Core Group 4: Routes utilizing a significant amount of I-64 – L1, L2, M, N

Geographic Grouping B: Organized by approach to Evansville

Core Group 1: Routes approaching Evansville by US 41 – A, B1, B2, C1, C2, D, E

Core Group 2: Routes approaching Evansville by SR 57 – F1, F2, H1, H2, I, J, K, L1, L2

Core Group 3: Routes approaching Evansville by I-64 – G, M, N

Geographic Grouping C: Organized by approach to Indianapolis

Core Group 1: Routes approaching Indianapolis by I-70 – A, B1, C1, E, F1, G, H1, I, J, L1, M

Core Group 2: Routes approaching Indianapolis by SR 37 or I-65 – B2, C2, D, F2, H2, K, L2, N

Geographic Grouping D: Organized by broad geographic corridor

Core Group 1: Western routes – A, B1, B2, C1, C2, D, E

Core Group 2: Central routes – F1, F2, G, H1, H2, I, J, M

Core Group 3: Eastern routes – K, L1, L2, N

Geographic Grouping E: Organized by areas served

Core Group 1: Predominantly western – A, E

Core Group 2: Western-Central-Eastern – C1, C2, D

Core Group 3: Central – I, J, M

Core Group 4: Central and Eastern – B1, B2, F1, F2, G, H1, H2, K

Core Group 5: Eastern - L1, L2, N

Scenarios

A total of five scenarios covering the range of reasonable value weights were examined. A description of each alternative is as follows:

Scenario 1: All ten performance families weighted equally with the two cost categories weighted at half the value of a performance family

Scenario 2: All ten performance families weighted equally with the two cost categories weighted equally (i.e., as two performance families)

Scenario 3: The three “core objectives” (i.e., travel time savings, personal accessibility, and I-69 interstate/international trade) double-weighted with all other performance families plus the two cost categories weighted equally

Scenario 4: The three basic “need/purpose concerns” (i.e., transportation, economic development, and national I-69 goals) plus the two cost categories weighted equally

Scenario 5: The two primary “need/purpose concerns” (i.e., transportation and national I-69 goals) double-weighted with economic development and the two cost categories weighted at parity

Tables 1-5 on the following pages summarize the results of the five scenarios. There is a table for each scenario. In each table, the rows provide information on each of the routes. The routes (rows) are ranked in order from best score to poorest. To the right of the route score and route ranking columns, each column corresponds to a geographic grouping. Under these column headings, the numbers that appear in each cell correspond to the core group number (see above) for that route as it is designated within that particular geographic grouping.

The best-ranking route within each core group is color-coded using the color scheme (shown above) associated with that geographic grouping. In other words, as the reader scans the column from top to bottom, the first time that a specific core group number appears, it has been color-coded. This denotes the best-ranking route in that core group.

Table 1: Scenario 1 Route Scores and Ranks

Route	Route	Route	Geographic Groupings				
Concept	Score	Ranking	A	B	C	D	E
F2	100.00	1	1	2	2	2	4
H2	93.99	2	1	2	2	2	4
B2	86.28	3	1	1	2	1	4
L2	79.60	4	4	2	2	3	5
H1	76.68	5	1	2	1	2	4
F1	73.66	6	1	2	1	2	4
C2	72.14	7	2	1	2	1	2
K	71.42	8	1	2	2	3	4
B1	71.15	9	1	1	1	1	4
N	69.64	10	4	3	2	3	5
L1	68.21	11	4	2	1	3	5
G	62.18	12	1	3	1	2	4
D	59.69	13	2	1	2	1	2
J	59.07	14	3	2	1	2	3
I	57.23	15	3	2	1	2	3
C1	55.27	16	2	1	1	1	2
M	49.16	17	4	3	1	2	3
A	29.08	18	2	1	1	1	1
E	28.85	19	2	1	1	1	1
NB	0.00	20	-	-	-	-	-

Table 2: Scenario 2 Route Scores and Ranks

Route	Route	Route	Geographic Groupings				
Concept	Score	Ranking	A	B	C	D	E
F2	100.00	1	1	2	2	2	4
H2	93.23	2	1	2	2	2	4
B2	84.19	3	1	1	2	1	4
L2	77.20	4	4	2	2	3	5
H1	73.68	5	1	2	1	2	4
F1	71.23	6	1	2	1	2	4
C2	69.35	7	2	1	2	1	2
B1	67.20	8	1	1	1	1	4
N	66.90	9	4	3	2	3	5
K	66.85	10	1	2	2	3	4
L1	64.21	11	4	2	1	3	5
G	58.35	12	1	3	1	2	4
J	55.66	13	3	2	1	2	3
D	55.11	14	2	1	2	1	2
I	54.98	15	3	2	1	2	3
C1	52.43	16	2	1	1	1	2
M	46.66	17	4	3	1	2	3
A	28.42	18	2	1	1	1	1
E	23.88	19	2	1	1	1	1
NB	0.00	20	-	-	-	-	-

Note: In Geographic Grouping A, Route “A” could be grouped in core group 2 or 3. For purposes of this analysis, it has been included in core group 2. Routes in bold have at least one first-place rank.

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Table 3: Scenario 3 Route Scores and Ranks

Route Concept	Route Score	Route Ranking	Geographic Groupings				
			A	B	C	D	E
F2	100.00	1	1	2	2	2	4
H2	93.07	2	1	2	2	2	4
B2	83.00	3	1	1	2	1	4
H1	78.29	4	1	2	1	2	4
L2	77.79	5	4	2	2	3	5
F1	75.91	6	1	2	1	2	4
C2	70.04	7	2	1	2	1	2
B1	69.94	8	1	1	1	1	4
K	69.73	9	1	2	2	3	4
L1	67.81	10	4	2	1	3	5
N	67.37	11	4	3	2	3	5
G	62.02	12	1	3	1	2	4
J	58.84	13	3	2	1	2	3
I	56.48	14	3	2	1	2	3
C1	55.20	15	2	1	1	1	2
D	55.02	16	2	1	2	1	2
M	48.76	17	4	3	1	2	3
A	29.05	18	2	1	1	1	1
E	28.45	19	2	1	1	1	1
NB	0.00	20	-	-	-	-	-

Table 4: Scenario 4 Route Scores and Ranks

Route Concept	Route Score	Route Ranking	Geographic Groupings				
			A	B	C	D	E
F2	100.00	1	1	2	2	2	4
H2	85.20	2	1	2	2	2	4
B2	65.82	3	1	1	2	1	4
F1	61.61	4	1	2	1	2	4
L2	58.32	5	4	2	2	3	5
H1	55.48	6	1	2	1	2	4
C2	50.42	7	2	1	2	1	2
N	47.34	8	4	3	2	3	5
I	46.87	9	3	2	1	2	3
K	41.97	10	1	2	2	3	4
C1	41.15	11	2	1	1	1	2
B1	40.32	12	1	1	1	1	4
J	38.33	13	3	2	1	2	3
L1	37.34	14	4	2	1	3	5
A	36.44	15	2	1	1	1	1
M	35.31	16	4	3	1	2	3
G	34.35	17	1	3	1	2	4
D	21.16	18	2	1	2	1	2
NB	18.57	19	-	-	-	-	-
E	0.00	20	2	1	1	1	1

Table 5: Scenario 5 Route Scores and Ranks

Route Concept	Route Score	Route Ranking	Geographic Groupings				
			A	B	C	D	E
F2	100.00	1	1	2	2	2	4
H2	88.44	2	1	2	2	2	4
B2	75.19	3	1	1	2	1	4
F1	74.03	4	1	2	1	2	4
H1	71.54	5	1	2	1	2	4
L2	70.22	6	4	2	2	3	5
K	66.20	7	1	2	2	3	4
C2	63.01	8	2	1	2	1	2
B1	60.49	9	1	1	1	1	4
N	58.15	10	4	3	2	3	5
L1	58.03	11	4	2	1	3	5
I	53.45	12	3	2	1	2	3
C1	52.96	13	2	1	1	1	2
J	52.36	14	3	2	1	2	3
G	51.23	15	1	3	1	2	4
D	42.10	16	2	1	2	1	2
M	40.25	17	4	3	1	2	3
A	29.49	18	2	1	1	1	1
E	18.90	19	2	1	1	1	1
NB	0.00	20	-	-	-	-	-

**Table 6: Tabulation of Routes
with First Place Rankings**

Route Concept	Number of First Place Rankings
NB	-
A	5
B1	-
B2	10
C1	-
C2	10
D	-
E	-
F1	2
F2	25
G	-
H1	3
H2	-
I	4
J	6
K	-
L1	-
L2	15
M	-
N	5

Findings

Perhaps the most significant finding that comes to light in the preceding tables is the remarkable degree of consistency in the first-place rankings among all five scenarios. Table 6 summarizes the tabulation of first-place rankings by route. With few exceptions, the pattern is that routes either have several first-place rankings (both within core groups and across geographic groupings) or none at all. This is significant because it suggests that the “high performers” are not overly dependent on the weightings that one might ascribe to a particular performance family (or even related groupings of performance families).¹

Also significant is the fact that typically (though not always) there is a fairly large difference in the route scores between first and second place rankings within the same core group. This fact suggests that a reasonable degree of confidence can be placed in a first-place ranking.

¹ This statement assumes that the analyst refrains from the use of extreme weights that would effectively hinge the entire screening process on one or two factors.

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Another significant finding is that certain core groups tend to garner higher route scores than other core groups. Consequently, in order to achieve the goal of geographic diversity it is inevitable that some route concepts will be carried forward for further analysis that have lower scores than other routes that fall into a higher performing core group.

Conclusion

The preceding analysis demonstrates that the rating of routes under a wide variety of scenarios and geographic groupings yielded very consistent results. Specifically, routes tended to either *never* perform best within a geographic grouping, or to perform best within a geographic grouping several times.

Since the performance of routes was consistent under a wide variety of scenarios, the analysis which led up to the screening of alternatives in effect assigned a consistent weight to all criteria. As displayed in Table 3-2 of the main text, routes were grouped geographically, and then assigned an equal weighting which reflected how well they performed on each of the ten families of performance measures. Capital costs and ongoing operating and maintenance costs were also assigned an equal weight with each of the ten families of performance measures.

The five alternatives selected for detailed study (A, C, F, J, and L) have five of the six highest number of first-place rankings, as shown in Table 6 of this Appendix. This sensitivity analysis was conducted prior to the screening process in order to ensure that the screening decisions did not hinge on one narrow set of assumptions. The analysis minimized any questions along those lines and validated the robustness of the screening conclusions.